PROJECT 7 OVERVIEW

Expand the Collection of "Near-Miss" Data to All Modes

INTRODUCTION

Background

Virtually all transportation incidents are preceded by a chain of events or circumstances – any one of which might have prevented the incident if it had gone another way. In a large number of cases, operators are aware of these "close calls" or "near-misses" and may have information that could prevent future mishaps. However, most of our modal programs are focused on collecting data only on events that meet the threshold of a reportable accident. Thus, the large majority of cases where we could capture useful data on accident precursors or on effective prevention strategies remain unexposed.

Collecting and analyzing reports of near-misses provide a route of access to the causes of hazards that have the potential of leading to crashes. Lessons learned from near-misses can be used in designing countermeasures that not only reduce the number of transportation-related safety incidents, but, in some cases, even prevent catastrophic events of certain types from ever occurring. Thus, high-quality data on near-misses is needed to strengthen preventive efforts and reduce the burden of transportation-related incidents on individuals and society.

The Department of Transportation (DOT) has been working toward the elimination of transportation-related fatalities and injuries in the United States. Toward this end, DOT has made a commitment to improve safety data collection and reporting across all transportation modes. As a result, a series of workshops held in 1999 and a Safety Data Conference in April 2000 brought together experts from different transportation modes who developed the Safety Data Action Plan (SDAP). The SDAP is comprised of 10 research projects intended to improve the quality and timeliness of existing transportation safety data, collect better data on accident circumstances, precursors, and leading indicators, and expand the use of technology in data collection.

This project attempts to: a) describe systems now employed in the collection of data on near-misses in various modes, b) specify requirements for collection and analysis of voluntary data that will be useful in prevention efforts, and c) propose studies aimed at expanding the collection of near-miss data across all transportation modes.

Purpose

The immediate purpose of the present project is to study near-miss events capable of leading to accidents within all modes of transportation. It involves the study of existing systems for identifying and reporting near-misses, identifying potential benefits and problems, exploring the transferability of reporting from aviation and maritime modes to other modes, and proposing a coordinated effort across DOT for implementing such systems.

A near-miss situation is one that could have resulted in accidental harm or damage but failed to in the absence of any specific measure designed to prevent it. The original title of the project refers to the term *near-miss*. However, the term "near" implies a spatial or temporal proximity that does not apply to the many situations that arise and are corrected well before and at a great distance from an actual accident. Some reported situations center on specific events, while others involve generally prevailing conditions. In this context, the term "unsafe situations" appears to be more descriptive and, therefore, is used in this research project.

The ultimate purpose of this activity is to provide statistical data that will lead to the prevention of accidents. To accomplish this, the data gathered must identify causes of unsafe situations in terms that can be applied to their reduction, and ultimately result in reducing the incidence and severity of transportation accidents.

A resolution adapted by the DOT Safety Council in January 2000 supported the development of precursor data for industrial and transportation-related safety incidences and, specifically, pointed in the direction of capturing information on factors associated with unsafe situations.

Objectives

The goals of this project are to study existing systems for recording and reporting unsafe situations, produce operational definitions and criteria for such situations in each transportation mode, identify potential benefits and problems with data collection, improve cross-modal utility of the data, and explore the transferability of unsafe situation reporting from aviation to other modes.

The Heinrich Pyramid depicts the relationship of accidents to two forms of unsafe situations. One consists of recorded *incidents* that produced consequences that could have resulted in injury, or damage meeting accident report thresholds, but failed to do so. The second level represents unrecorded *occurrences* of events or conditions that raised the danger of an accident or incident, but due to fortunate circumstances, failed to do so. Both of these represent sources of information that could be applied to the prevention of accidents if they were reported, analyzed, and disseminated.

When it comes to causative factors, unsafe situations represent less a separate subset of precursors to accidents than simply the same precursors with different outcomes. The conditions that lead to an unsafe situation on one occasion can result in a real accident on another. If that were not the case, there would be little point in studying near accidents. What the additional study of unsafe situations brings is:

1. a greater number of episodes from which accident contributors can be gained, and
2. the opportunity in some instances to identify preventive measures from those steps that actually succeeded in avoiding an accident.

Methodology

The project objectives were met in the following four phases.

Development of Unsafe Situation Data Systems Matrix

The first step in meeting objectives of the project was to examine the systems engaged in data collection on unsafe situations and to identify the properties of each. These included the manner in which reports are collected, the information furnished, protections to reporters, access to data, including web access, analyses performed, and reports furnished. This work has been accomplished by soliciting input from personnel involved with these systems and technical experts from transportation modes, as well as through extensive literature review.

Human Factors Taxonomy

The second part of the project involves development of a human factors taxonomy – a classification structure developed as a key piece to the utility of the unsafe situation data systems across transportation modes. While the project is concerned exclusively with analysis of unsafe situations, any human factors taxonomy would apply equally well to the accidents, whose prevention is the ultimate goal of such analysis.

Individual reports of unsafe situations have been useful in identifying causes that are sufficiently serious as to serve as a basis of corrective action. The bulk of reporting, however, involves situations that may not be serious enough to prompt action by themselves but occur often enough to merit attention. A formal mechanism for identifying frequent situations would require some means of aggregating those with similar causes to permit the compilation of statistics. The need for such taxonomies is greatest for the most frequent and most diverse of causes, those involving human factors.

Guidelines for Voluntary Reporting of Unsafe Situations

The third step in the project was to develop guidelines for systems focused on both collecting and analyzing unsafe situation data. Two such systems were:

1. developing taxonomies for classifying and coding causes of unsafe situations, and
2. devising systems of voluntary reporting across modes.

Research efforts concentrated on voluntary reporting mechanisms, incentives, and barriers for voluntary reporting, data recording methods and databases, the types of data available from unsafe situations, the scope and quality of the data, means used to infer causes from information furnished, and the statistical methods used to estimate the prevalence of various causative factors.

Automated Methods of Data Collection

One additional source of information on unsafe situations involves automated methods of data collection. A segment of the project was devoted to this topic and included a discussion of technological methods currently in use and new ideas for automatic reporting.

Information Sources

Materials presented in this project were obtained from the following agencies and sources of information.

Department of Transportation

- Bureau of Transportation Statistics (BTS)
- Federal Aviation Administration (FAA)
- Federal Highway Administration (FHWA)
- Federal Motor Carrier Safety Administration (FMCSA)
- Federal Railroad Administration (FRA)
- Federal Transit Authority (FTA)

- Maritime Administration (MARAD)
- National Highway Traffic Safety Administration (NHTSA)
- Research and Special Programs Administration (RSPA)
- United States Coast Guard (USCG)

Other Organizations
- Aviation Safety Reporting System (ASRS)
- Confidential Human Factors Incident Reporting Programme (CHIRP)
- National Institute for Occupational Safety and Health (NIOSH)

Safety Data Task Force
A Safety Data Task Force with representatives from each transportation mode, safety policy and analysis offices, and BTS staff provided feedback on the project's scope, objectives, and progress.

Volpe Group Background Report
The Volpe National Transportation Systems Center prepared a background report describing existing and planned voluntary safety reporting systems. The Volpe Report outlined the DOT confidentiality regulations and explored opportunities for extending BTS's legislative data protections to other data systems.

PROCESS

Modal Matrix

A search for systems that collect information on unsafe conditions revealed several either in operation or on the drawing board. The search encompassed unsafe situations that caused incidents resulting in damage below the threshold for reporting, as well as accidents themselves, in order to take advantage of characteristics that apply across all levels of hazard. For each system, these included its history, the information being collected, its sources, the analyses being performed, information being furnished, and the means of access. Information presented in a matrix format is the most effective way to consider individual components in a systematic manner. Furthermore, it helped the investigators to benchmark the aviation industry practices, discover previously unidentified problems with unsafe situation data reporting, acquisition, management, and analysis, and recommend solutions for transferring the aviation experiences to other transportation modes.

Several systems have been developed and implemented in aviation in the United States and abroad. The Aviation Safety Reporting System (ASRS) is a nationwide system that collects, analyzes, and responds to voluntarily submitted reports of unsafe aviation situations in order to lessen the likelihood of aviation accidents. The ASRS and its structure served as a prototype for other reporting systems in aviation as well as systems within other modes listed here.

Aviation
- Near Midair Collisions System (NMACS) – United States
- FAA Accident/Incident Data System (AIDS) – United States
- National Transportation Safety Board (NTSB) Aviation Accident/Incident Database – United States
- Confidential Human Factors Incident Reporting Programme (CHIRP) – United Kingdom
- International Civil Aviation Organization (ICAO)
- The Global Analysis and Information Network (GAIN) (proposed)

Maritime

- The Nautical Institute International Marine Accident Reporting Scheme (MARS)
- Safety Incident Management Information System (SIMIS) – United States
- The International Maritime Information Safety System (IMISS) (proposed)

Motor Carrier

- Hazardous Materials Incident Report System – United States

Rail

- Signals Passed at Danger (SPAD) system – United Kingdom

Intermodal

- Securitas – Canada

A great volume of data has been and will be collected on unsafe situations in transportation. Most of the systems for collecting information on unsafe situations come from aviation, primarily commercial air carriers. While similar concerns have stimulated efforts to extend the approach to the maritime industry, progress has been less evident. Thus far, little effort appears to have been devoted to the effort by the rail industry. Within modes where accidents are sufficiently plentiful to provide insight into causes, there is still room for examining categories of operation characterized by relatively few but very serious accidents.

Human Factors Taxonomy

In order to aggregate data and compile statistics on the causes of unsafe situations, some means of classifying them into categories is needed. This is particularly challenging for causes arising from the human component. The more tangible aspects of causes, relating to equipment, weather, and surfaces such as highways, runways, and rails, tend to fall into numerous but readily identifiable categories. However, the characteristics of people that lead to unsafe situations cover a wider range, particularly their errors, which are unique to each situation.

Taxonomies of human causes have been structured at two levels. One involves the specific errors that lead to individual situations, where "error" refers not only to mistakes that make the person responsible for the situation but also the absence of actions that could have prevented them. The second level involves predisposing factors that lead to errors, including the psychological and physical characteristics of people, the hardware and software with which they interact, and the surrounding physical, social, and organizational environments in which activity takes place. Where equipment fails, the first step is to find out specifically what broke and then correct the design, manufacturing, or maintenance flaws that allow the failure to occur. Similarly, efforts to overcome the causes that lie in human factors must start by identifying the specific errors and then correct the predisposing conditions that lead to them.

Voluntary Reporting of Unsafe Situations

The process of developing cross-modal guiding principles for voluntary reporting of unsafe situations was based primarily on the experiences of the ASRS demonstrating that analysis of such events is key to improvement in transportation safety. In order to capitalize on the success of the ASRS and other programs, any system geared toward voluntary reporting should be based on the following premises:

- voluntary participation
- reporter confidentiality
- guaranteed immunity
- system operated by a nonregulatory third-party agency
- buy-in and support from the community
- ease of data submission
- follow-up opportunity for further investigation, and
- feedback—evidence of data output, implementation, and countermeasures.

Because each transportation mode has its unique characteristics and environment, the applicability of these factors may vary. However, there are common themes. These guiding principles lay down the rules for future investigations that will put them into practice. A proposal for a pilot study addresses the transferability and future implementation.

Automated Collection of Unsafe Situation Data

The reporting of accidents, incidents, and occurrences by participants and witnesses has provided information capable of guiding preventive efforts in all transportation modes, at least to some degree. However, it takes time, and is dependent on both the ability and willingness of informants to report events accurately. Advances in technology offer the opportunity to record events automatically in a way that will allow the nature and origins to be ascertained and verified objectively.

RECOMMENDATIONS

On the basis of project findings, the following proposals for collection and analysis of unsafe situation data were developed.

Outcome Classification and Coding

Development of taxonomies for collecting and coding of unsafe situations at the levels of human error and the predisposing factors that produce them is of high and urgent priority. The factors that predispose errors tend to fall into the same general categories across modes and have been the subject of suitable taxonomies, most notably the SHEL matrix. However, the behaviors required by various forms of transportation and, therefore, the errors that arise, vary across modes as well as across operations within mode. While some taxonomies of human error have been developed and applied to prevention, they do not involve the modes given primary attention for analysis of unsafe situations.

Voluntary Self-Reporting

A high-priority study, specifically called for in this project, is extension of voluntary self-reporting from aviation to other transportation modes. Where accidents occur, they are typically the subject of mandatory reports by investigating officers and those involved. However, where events only raise the possibility of accidents, the only sources of information are the parties involved in them, and requiring reports becomes problematic. The alternative is voluntary reporting, which has been successfully employed in aviation for the past 25 years. A proposed study would examine the requirements for extending voluntary self-reporting to other modes, to include sources of, and ways of overcoming, possible resistance.

Marine Traffic Study

The technology employed in studying flight patterns could be extended to marine traffic

through an additional project. To permit tracking ship movements in areas not readily registered by ground-based radar, other forms of measurement (e.g., use of satellites and Global Positioning System (GPS)) would be studied.

Large Truck Headway Analysis

One specific extension of technology to another mode will be collection of truck headway data to compile statistics capable of revealing the conditions associated with unsafe following distances. The study could employ rearward distance measurement devices (e.g., laser) to detect short headways of trucks encountered in the traffic stream as well as location-determining devices such as GPS to allow headways to be associated with various roadway characteristics.

CONCLUSION

The collection, analysis, and reporting of data describing unsafe situations that do not result in reportable accidents can be beneficial in preventing damage, injury, and death within all modes of transportation. Such data are of particular value in modes characterized by relatively few but highly serious accidents.

While the nature of unsafe acts tends to be mode-specific, the basic methods of data collection and analysis, developed largely in aviation, can be extended across modes. Within the United States, voluntary reports have been the prevalent source of information concerning unsafe acts.

Both voluntary reports and automated systems of data collection can be successful in securing information on the nature and causes of unsafe situations in transportation. In both cases, the confidentiality and privacy of information sources have to be effectively protected.

Thus far, attempts to correct conditions leading to unsafe situations have been based primarily on individual reports. Gaining greater benefit from reporting systems requires developing means of classifying causes in a manner that allows data aggregation and identification of the most prevalent causes.

The greatest challenge to classification and aggregation of causes involves human error, which may be defined as lack of any action that could have prevented a situation from arising, and could be reasonably expected (it does not involve culpability or blame). The distinctive elements of individual errors complicate grouping into categories.

Although error taxonomies in some transportation modes have been successful in identifying and initiating steps to prevent the most frequent needs, they are based primarily on accidents, and are as yet lacking in those currently subject to self-reporting systems. The need for taxonomies is recognized, and efforts to develop them are currently under way.

Based on identified errors, a wide range of remedial processes can be employed to address predisposing conditions involving underlying physical and psychological, hardware, environmental, social, and organizational factors. These factors are largely the same across modes, and available taxonomies of predisposing conditions can be applied to their classification.

An assumption underlying the search for causes of unsafe situations is that they are also the causes of accidents, and processes designed to prevent them would also prevent accidents. Therefore, taxonomies of human

error and their predisposing conditions would apply equally to the analysis of accident data.